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PRODUCTION

JANUARY 1984

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CONGRESSIONAL INFO SERV.
SRI ACQUISITIONS P0563251
4520 EAST-WEST HWY.
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BETHESDA, MD 20814

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Production Publishing Company, Inc.
Vol. 93, No. 1

PRODUCTION

January 1984

Cutting Tools Offer Golden Opportunities

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THE COVER:
"Jewels of the metalworking industry," TiN coated cutting tools, provide longer life and more machine uptime.

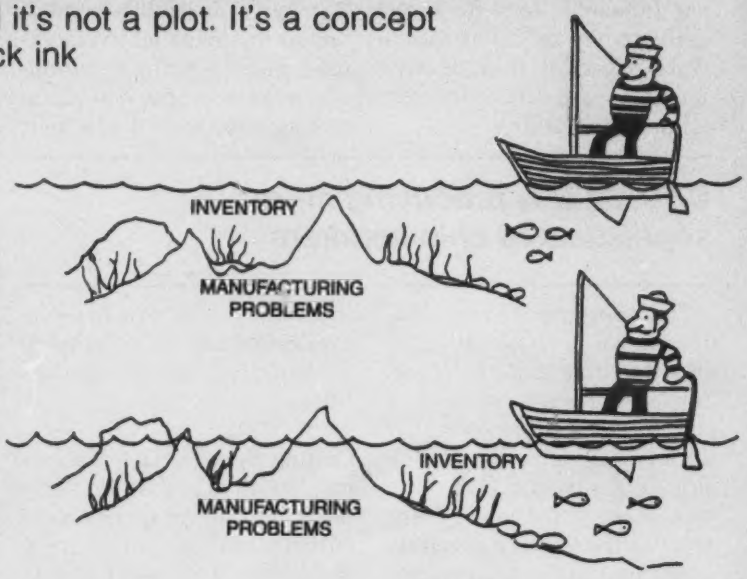
NEXT MONTH:
Newly designed hobbing machines advance gear cutting technology. Advantages are increased flexibility, versatility and substantially improved precision.

Published by Production Publishing Company, Inc., Box 101, Bloomfield Hills, Michigan 48303-0101 (313) 647-8400

JUST-IN-TIME WORKS!

It's not a panacea and it's not a plot. It's a concept that manufactures black ink

Drew Winter
News Editor



If there is one thing that symbolizes the Just-in-Time (JIT) concept, it is two crude drawings of a man in a boat floating on a river. In the top drawing, the water is high and the boat skims effortlessly over a large pile of submerged rocks. In the second drawing, the water level is far lower and the boat is endangered by the rocks. The rocks are labeled "manufacturing problems" and the water is labeled "inventory."

While many manufacturing people will concede that inventory is used to cover up problems such as unreliable or poorly maintained equipment, poor quality vendor materials, inadequate operator training or poor management, most do not realize just how costly or counterproductive the practice is—at least until they get involved with JIT.

"Just-in-Time is a philosophy," says Edward V. Spurgeon, program manager, Just-in-Time Production Management and Systems Consulting, General Electric Co., Bridgeport, CT. "It isn't the kind of thing that is a program for a year and then it ends. It is a long-term philosophy of deliberately lowering the inventory in your plant, streamlining the way you flow materials through, exposing the problems and permanently resolving them."

Some Benefits. Harley-Davidson Motor Co., Inc., Milwaukee, (which refers to its JIT program as Materials-As-Needed, or M.A.N.) cut its in-process and in-transit inventory by $20 million at just the company's York, PA, assembly plant.

At General Motors' sprawling Buick facilities in Flint, MI, JIT techniques have helped the company cut its inventory on hand and in transit from $48 million to $25 million. Clarence E. Root, Buick Div.'s materials director, is hoping to cut that figure down to $13 million when the $300-million renovation project at Flint called Buick City comes on stream in the summer of 1985. Buick City will produce front-drive Buick LeSabre/Oldsmobile 88 cars, and it will be doing the same job with 1½ million sq ft that the company traditionally would have needed 3½ million sq ft of plant space to do.

JIT programs have been started at approximately 40 different General Electric Co. plants. Inventories have been trimmed in some areas by up to 70 percent and labor productivity gains of up to 35 percent have been made in some pilot applications.

At Hewlett-Packard's Vancouver Div., Vancouver, WA, the company was able to reduce the space necessary to manufacture its line of computer workstation printers from 10,000 sq ft to 2500 sq ft (over a two-year period) while maintaining almost the same production capacity.

According to Bruce Harvey, materials manager, the Vancouver Div. now has ⅕ of the work-in-process (WIP) it orig-

inally had; there is far less scrap and rework; cycle times have been drastically reduced and material leadtimes are now down to two weeks in some cases.

As these figures indicate, inventory reduction is just the tip of the JIT iceberg. For instance, at Harley-Davidson's Milwaukee engine plant, typical setup times on engine manufacturing operations have been cut an average of 75 percent.

"Initial impressions of Just-in-Time tend to focus on inventory reductions," says Lionel (Bud) Chicoine, corporate vice president, Purchasing and Supply, Ford Motor Co., Dearborn, MI. "Most readily pictured is an array of supplier trucks arriving hourly at a plant gate. Let me emphasize that frequent deliveries and attendant inventory reductions are merely the byproduct of a much more elaborate plan. Perhaps the trucks should be even the last step in the implementation process."

Thomas Gelb, vice president-operations, Harley-Davidson Motor Co., Inc. and GE's Spurgeon agree with this assessment.

The following is a breakdown of just what the components of a successful JIT program really are, based on extensive interviews with both OEMs and suppliers who have become involved with JIT:

EMPLOYEE INVOLVEMENT

Attention to detail is the key to

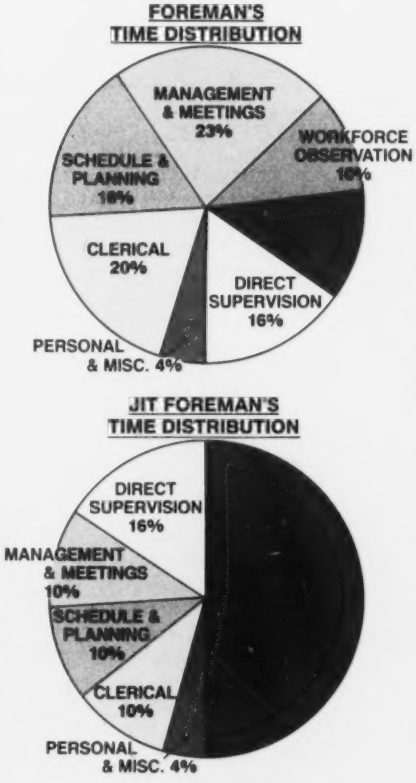
Obstacles to JIT (and how to overcome them)

by Edward V. Spurgeon
Program Manager-JIT
General Electric Co.

Top management is not committed. People do what the boss wants. Therefore, an education process needs to take place at the top of a business. Top executives need to understand what JIT is, what it can do and where it works. Once they have this information, they usually support JIT. Then education, training and implementation proceed with general managers and their plant organizations.

Lack of manpower. JIT is mostly a learning process. You don't need new people to do new things. You need existing people doing old things differently. An example would be if a manufacturing engineer is investigating the purchase of a new high-speed press, he thinks beyond the usual tons of capacity and strokes per minute. He looks into ease of maintenance, reliability, setup time and whether he can locate the press close to the next operation. So what's needed is an education program to instill JIT concepts throughout your organization.

Lowering inventory causes too many problems. One way to solve exposed problems is to get managers and specialists out into the factory solving problems. We typically find that JIT plants have no more staff than non-JIT plants. The difference is that in non-JIT plants salaried workers are spending enormous amounts of time forecasting financial results, reporting on financial results, obtaining approvals and attending meetings instead of solving manufacturing problems.



Traditional performance measurements conflict with JIT. Internal performance measurements were developed years ago when the focus was on specialization of tasks. For example, buyers are measured primarily on material cost with minor emphasis on quality or inventory. Manufacturing engineers are measured largely on labor costs per piece instead of on quality or inventory carrying costs. Quality control is measured on service call rates or complaints, not scrap and rework. It is well within our power to change these narrow measurements and orient new measurements more toward total business objectives.

Suppliers are not located nearby. Getting suppliers to make JIT deliveries has gotten a lot of publicity, but it probably accounts for less than 10 percent of the benefits of JIT programs. The big gains come from improving productivity and quality by flowing parts through your own factory on a daily basis. Until you have reached this point, it is not too important to have your supplier deliver on a daily basis.

No money for new programs. Managers of businesses that are struggling often feel they can't invest a nickel on any new programs. They say "Let's wait until business improves." The sad fact is that if they used JIT to free up dollars locked in excess inventory, they would be able to invest in new programs and equipment.

successful implementation because it requires a great deal of cooperation, acceptance and input from both salaried and hourly personnel.

How organized labor will react to JIT is still a big question mark

Just how organized labor will react to overall JIT techniques is still a big question mark. The strike at Chrysler's Twinsburg, OH, stamping plant dramatically showed this vulnerability.

The whole idea of eliminating large inventories sends shivers down the spine of those in industry accustomed to holding "safety stocks" of raw materials in anticipation of work stoppages. With no material "cushions" to fall back on, it is conceivable that many manufacturers could find themselves in very weak positions when negotiating with organized labor (another large rock surface).

The UAW refused PRODUCTION's requests for interviews to explore this topic further. One thing that is clear, however, is that if JIT is really going to work like it is supposed to, organized labor will have to be solidly behind it.

But unionized employees aren't the only people that have to be convinced of JIT's merits. "Although Harley-Davidson is making progress, it is very slow. Changing the attitudes and past practices of first line and middle management is the real challenge," says Thomas Gelb.

REDUCED SETUP TIMES The ideal situation is zero setups accompanied by lot sizes of one, according to JIT philosophy. Implementers realize this is too idealistic for most current situations, but in order to accommodate the smaller lot sizes the concept dictates, setups have to be improved. Harley-Davidson uses a three-phase approach, which begins with simple, common-sense fixturing improvements and ends with actual product design changes to commonize parts and manufacturing operations.

STATISTICAL QUALITY CONTROL JIT requires a specific quantity of good parts. SQC (performed in-house and by suppliers) is an absolute necessity to provide the quality that JIT demands.

GROUP TECHNOLOGY Approximately 30 percent of floor space can be saved by arranging equipment according to part families rather than equipment families. Very short setup time makes this possible where volume is not high enough for dedicated equipment. Cellular or "focus flow" arrangements mean all departments are self-sufficient

A Supplier Who Signed On

Every day a truck from Harley-Davidson Motor Co., Inc., pulls up to the loading dock of Milsco Manufacturing Co., Milwaukee. It then carries its load of 160 motorcycle seats and assorted accessories on an overnight trip of 800-plus miles to Harley's assembly plant in York, PA. On its way back to Milwaukee, it drops off finished motorcycles at various dealerships on its route.

A diversified manufacturer of custom seating products, Milsco was the first supplier to sign a long-term JIT contract with the motorcycle manufacturer.

"Getting a successful long-term contract relates directly to what kind of relationship you have had with the supplier," says Leroy Zimdars, the Harley-Davidson purchasing agent responsible for negotiating all of the company's long-term contracts.

Milsco has been doing business with Harley-Davidson for 48 years. According to David R. Anderson, president of Milsco, 20 percent of his company's capacity is devoted to Harley (6 percent of that is aftermarket). Though Anderson says his company has a long way to go in the implementation of JIT, he also tells how Harley's M.A.N. system is now an extension of Milsco's MRP system.

"The best thing you can do for a supplier, besides giving him more business, is to give him a steady schedule," says Anderson. "Harley-Davidson is doing that and it's very helpful.

"What Harley-Davidson did, and did very well, is that they just didn't say 'This is what we want to do,' " Anderson continues. "They approached us two years ago and asked our opinion of the concept. We told them that we thought it was a pretty good idea."

David R. Anderson

and include the equipment necessary to produce a finished part from raw materials, such as castings. Each department is put under the control of one supervisor, who is like a mini plant manager, controlling all production, parts, machine utilization and materials flow. There is no paperwork within the department.

CONTAINERIZATION The ideal container should not have more than 10 percent of one day's production. It should be easily transportable within the plant and it should be reusable. Cardboard or dunnage should be eliminated. If parts have to be protected, plastic or other reusable protective materials should be used. When high volumes of parts are used in an operation, it is recommended that smaller bins or tubs be shipped within a larger, reusable overall container.

SCHEDULING (KANBAN) CARDS In various pilot programs at Harley-Davidson the scheduling cards indicate the part machining number, describe the piece, tell what department it is coming from, how many parts go in the container, what kind of container it is, who the supplier is and how many cards/containers are in the whole system.

The cards are put on a rack adjacent to the appropriate cell (there are a limited number of slots) to signal which parts have to run. When parts are in-process, the cards are shifted to the other side of the rack, freeing up the few slots in the incoming rack. When the container is empty, its corresponding card is put into the mail to the appropriate supplier (mail time is built into the system). In its current, imperfect state, the parts shipment trigger is three cards. When a supplier involved with the card system gets his third card in the mail, a truck with three full bins of product (cards attached) is sent to Harley-Davidson.

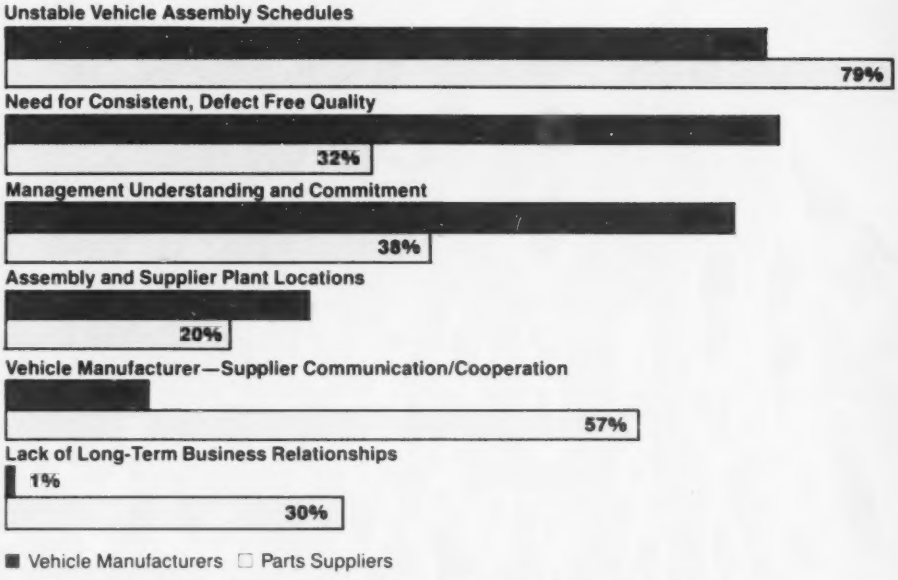
MASTER SCHEDULING A constant flow of parts between suppliers and users is the key to the success of the JIT concept. If the supplier knows on a long-term basis how much product to make and at what intervals it has to be delivered, he can make arrangements with his suppliers and within his plant to work out his own economies of scale.

For example, at Harley-Davidson, two weeks before the start of the month manufacturing, marketing and finance people sit down and determine what the next month's production schedule will be. That number is then frozen, regardless of the demands of the marketplace.

Forecasts are then made for the following month which cannot vary more than ±10 percent from actual production volumes, and for the month after that, they cannot vary more than ±20 percent.

LONG-TERM CONTRACTS Suppliers need strong incentives to make the philosophical and financial commitments that the concept requires. A fair, long-term contract that allows the supplier to lower his costs and stabilize his margins is one of those incentives.

Problems To Be Overcome In Implementing Just-In-Time Approaches



A Delphi study released last summer by Arthur Andersen & Co. indicated that automobile manufacturers and their suppliers have differing views on how to best implement Just-in-Time manufacturing. A number of groups and individuals, most notably the Detroit-based Automotive Industry Action Group (AIAG), are working to surmount this communication problem

TRANSPORTATION CONSOLIDATION Contrary to popular belief, based on Japanese practice, geography is not as important to JIT as most of the other factors mentioned. Suppliers can effectively participate from diverse areas of the country if truck fleets and routes are properly planned, managed and pooled. It is likely that most trucks will make a variety of stops daily at competitors on the way to a user's gates.

COMMUNICATION Poor user/supplier communication is a major reason suppliers complain that JIT manufacturing is a plot to transfer inventory and costs to them. Insufficient communication often leads to misinterpretation of order changes and inappropriate action on the part of the supplier. At least one major manufacturer, in recognition of this problem, is talking about installing computers at its suppliers that link them directly into its MRP system.

"Just-In-Time is the most meaningful thing that has happened since Henry Ford first tied a rope to a car and started the assembly line."

—Thomas Gelb
Vice President - Operations
Harley-Davidson Motor Co., Inc.

SUPPLIER TRAINING AND EDUCATION Suppliers cannot be expected to successfully participate in a JIT program without it. They must learn what the new needs of the user will be and how they can structure their organization and operations to meet those needs. More importantly, the user must educate and assist suppliers in implementing JIT concepts in their own plants. JIT can only truly succeed when it is practiced all the way through the production system, from raw materials to the finished product.

ELIMINATION OF ADVERSARIAL SUPPLIER/USER RELATIONSHIP "A vendor is somebody you go down the street and buy a hot dog from," says Hewlett-Packard's Bruce Harvey. "A supplier is someone who works with you to do a job."

It Can Work. Despite much automotive industry hype, Milwaukee-based Harley-Davidson Motor Co., Inc., is the only implementer of JIT PRODUCTION interviewed that is actively trying to convert its suppliers, potential suppliers as well as those in its own operation to JIT with a religious fervor. Called *Partners-In-Profit*, the presentation it makes to suppliers is structured like a high-powered sales pitch, where the question "What's in it for me?" is answered.

The benefits of the Harley-Davidson M.A.N. (materials as needed) program include:

- A long business relationship with Harley-Davidson
- Reductions in paperwork
- Three and five-year contracts for specific part numbers
- A schedule for each part number sent on a monthly basis, allowing planning for more efficient work schedules and working toward master schedules
- Decreased setup time
- Better process flow
- Less work-in-process
- Shorter leadtimes
- Implementation of statistical process control
- Elimination of final inspection/costs
- Cooperative problem solving
- Standardized packaging and shared expenses

According to LeRoy Zimdars, the purchasing agent who was recently put in charge of establishing long-term M.A.N. contracts, two suppliers have signed on so far and he is at different stages of negotiation with 15 other companies. The presentation has been shown to approximately 60 potential long-term suppliers so far.

Getting suppliers involved in a mutually beneficial arrangement is one of the most difficult parts of the JIT concept, admits GE's Spurgeon. "Our philosophy is not to run out and try to get our suppliers to operate JIT before we get our own house in order," he says. "We are currently concentrating internally on flowing our parts through the various shops on a daily basis. When we do get our parts requirements on a daily basis, then we'll go to our suppliers. But we will be doing it on the basis that there has got to be something in it for them, and that we will be able to show them how to do it without increasing their costs.

"We're going to have to go to longer-term commitments with them, have fewer suppliers, have them located nearby and have specifications and drawings they can meet. That is a major piece of work that has to be done." □

For further information on groups, consultants and books on JIT, circle **500** on PRODUCTION's Reader Service Card.

1984 CAPITAL SPENDING UP 32%

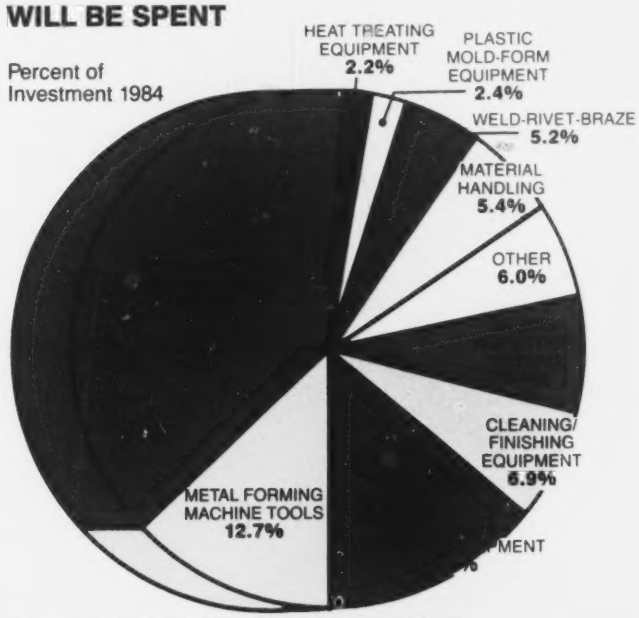
by Edward D. McCallum Jr.
Director-Business Operations

Increased incoming orders are the basis for growth in capital spending by the metalworking industries after two very lean years.*

$9.3 billion for new equipment purchases. That's the figure we're using for our 1984 projections. That's up 32 percent from the $7.0 billion we believe was spent in 1983. It's not a great year compared to spending patterns of the second half of the 1970s, but it's encouraging.

Using projected capital dollar investments of the $9.3 billion pie, we are looking at industry equipment buying along these lines: Metal-cutting machine tools, $3.58 billion, of which approximately $2.36 billion will be sourced domestically; metal forming equipment, $1.18 billion, of which approximately $800 million will be domestic-sourced; assembly machines and equipment, $1.29 billion; cleaning and finishing equipment, $642 million; weld-rivet-braze equipment, $483 million, of which welding equipment makes up 85 percent of the investment; gaging-inspection-testing equipment, $642 million, with inspection equipment accounting for almost 60 percent; material handling, $502 million; heat processing equipment, $205 million; and plastic molding equipment, $233 million.

HOW THE 1984 CAPITAL EQUIPMENT DOLLAR WILL BE SPENT



Source: PRODUCTION's Capital Spending Forecast 1984-85

The Overall Spending Profile

You're typical if your plant is planning its 1984 investment for machinery and equipment as depicted in the chart on this page.

You're also typical if in 1984 . . .

Your plant employs	Your machinery/equipment expenditures are
Less than 50 persons	$ 134,169
50-99 persons	$ 156,138
100-499 persons	$ 551,818
500-999 persons	$1,108,973
1000 or more persons	$2,905,805

Other Highlights

• You were operating at 72 percent of capacity in the late summer of 1983, up from 69.5 percent a year earlier.

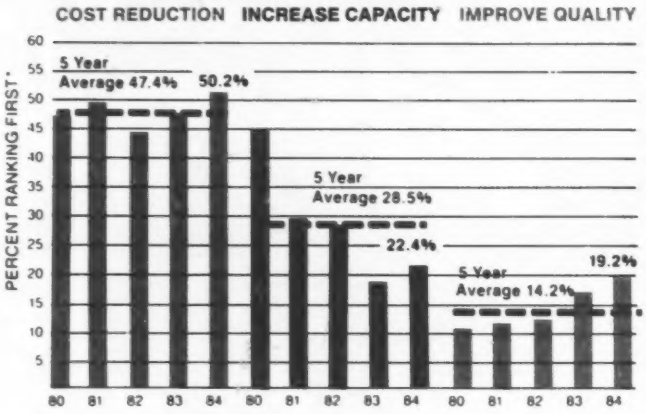
(NOTE: At the time we went to press, you were operating at 78 percent.) 65.4 percent of you planned to operate at a higher level of capacity in 1984, while only 3.8 percent thought they'd be operating at a lower level. And with about half of you reporting increased orders as the reason for higher planned operating rates, we believe the increase is based on economics

**Survey Scope: Plants reached by PRODUCTION in: Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment; and Instruments (SIC 38). 1984 figures are projected from 2525 respondents from 13,500 plants contacted in keeping with past procedures.*

rather than optimism.

- About 34 percent of you reported having approved budgets while another 44 percent expected to have approval by the end of 1983. The remainder wouldn't know their status until after January 1, 1984. Only 8 percent of 1984 budgeted equipment dollars have been placed with suppliers.
- First-year return-on-investment (pre-tax) requirements of 33 percent are unchanged from 1983.
- As in the past, your continuing reliance on and use of numerically controlled equipment is evident. Over the next three years, 46.4 percent of the total respondents plan CNC equipment purchases. Almost six out of ten plants (59.3%) report use of CNC, up from 55.9 percent one year ago. Horizontal and vertical machining centers and horizontal turning machines continue to account for the largest share of CNC purchases over the next few years.
- 10 percent of all responding plants expect to purchase EDM equipment 1984-86. Of these, approximately 60 percent will buy wire EDM.
- 40 percent of the total respondents report they will purchase a portion of their equipment needs from offshore suppliers. The breakdown of these: 52.3 percent plan metalcutting purchases; 11.7 percent plan metal forming purchases; 12.3 percent plan gaging-inspection-testing purchases. Why offshore? 68.7 percent said equipment quality, 62.8 percent said price, 41.1 percent said availability, and 21.3 percent said service.

OVERALL MOTIVES FOR PLANNED MACHINERY/EQUIPMENT INVESTMENTS TOTAL RESPONDENTS 1980-1984*



*Some respondents ranked more than one motive first
Source PRODUCTION's Capital Spending Forecasts 1980-1984

The need to improve quality starting last year is the most dramatic development indicated on this chart. Other motives, not graphed, include: New product/models 16.9 percent ranking first, more make-less buy with 7.5 percent ranking first, followed by energy reduction ranked first by only 3.9 percent of the respondents

Advanced Manufacturing Technologies

Manufacturing Cells. 13.7 percent of the total respondents plan purchase of manufacturing cells over the next three years. A cell is defined as comprising one materials handling device servicing multiple machines, coordinated and paced by a computer or programmable controller.

Flexible Manufacturing Systems (FMS). 11.5 percent of all plants responding plan purchase of FMS over the next three years. An FMS is defined as comprising multiple materials handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.

Lasers. 14.1 percent of all plants responding plan laser purchases 1984 through 1986. Most lasers will be purchased for gaging/measurement (7.3%). Cutting is the second most popular process with 4.2 percent of total respondents planning purchase, followed by welding (3.3%), drilling (2.5%) and heat treat (1.0%).

Robotics. More than a third of the responding plants (33.9%) will buy robots in the next three years. That reflects a continuing growth rate increase. Two years ago the figure was 21.6 percent; last year, it was 30.5 percent. Robot usage and planned usage breaks down as follows:

Robot Use	Current	Planned
Arc Welding	6.2%	4.6%
Spot Welding	2.5%	2.5%
Assembly	11.7%	7.0%
Load/Unload	15.3%	10.8%
Material Handling	8.7%	6.1%
Spray Paint	6.0%	5.1%

EDITOR'S NOTE: *A complete presentation of the data compiled for the 1984 survey will be presented in PRODUCTION's Manufacturing PLANBOOK to be published in March 1984.*

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RODUCTION's

Manufacturing PLANNING 1984

Capital Spending Forecast 1984
- Spending up 32% over 1983
- Market profile

Productivity
- How to define, measure and improve it
- Worksheets and charts

Annual Technology Update
- Focus on recent developments
- Quick reference category listings

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Production Publishing Company, Inc.
Vol. 93, No. 3

PRODUCTION®

March 1984

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Capital Spending—1984 . . . . . p. 41

The results of PRODUCTION's 15th annual Capital Spending Survey indicate a 32 percent increase over last year's spending; enable you to note changing trends, objectives in machinery/equipment purchase/use; allow you to compare your planned machinery/equipment investments with others in your industry

2

Productivity . . . . . p. 49

How To Define, Measure and Improve It

A guide for those who are striving to improve productivity. Based on information from a recognized authority in the manufacturing field—in contrast to the usual abstract approach, the guide presents facts and worksheets that have been used successfully by several companies to lift their own productivity

3

Update . . . . . p. 71

This section is designed to acquaint you with the latest developments for a wide variety of manufacturing improvements. Arranged by major categories and subcategories, Update contains brief descriptions of over 450 products that have been introduced or upgraded during the past year

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- Washington Impact
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THE COVER:
Machining of the metal plate on a Milwaukee Series VB-4 machining center courtesy of Kearney & Trecker Corp.
Photography by Jack Kausch

NEXT MONTH:
Spotlight on production grinding details machine developments, process improvements and builders' overviews

Published by Production Publishing Company, Inc., Box 101, Bloomfield Hills, Michigan 48303-0101 (313) 647-8400

CAPITAL SPENDING

Spending up 32 percent over one year ago.

Flexible operations...increase use of computers in manufacturing...EDM (Electrical Discharge Machines) use broadens ...robotics and lasers pass the curiosity stage...quality as a reason to buy equipment increases in importance. These are some of the highlights of PRODUCTION's 1984-85 Capital Spending Survey, the fifteenth conducted annually since 1970.

How the capital equipment dollar will be spent . . . . . p. 42
Cells and Systems . . . . . p. 42
Robotics . . . . . p. 43
Lasers . . . . . p. 43
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Industry spending patterns by type of equipment . . . . . p. 46

Survey Scope: Plants reached by PRODUCTION in: Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37), and Instruments (SIC 38). 1984 figures are projected from 2525 respondents from 13,500 plants contacted in keeping with past procedures.

Capital Spending 1984

The results of PRODUCTION's Capital Spending Survey enable you to—

- Note changing trends, objectives in machinery/equipment purchase/use
- Compare your planned machinery/equipment investments with others in your industry

Edward D. McCallum Jr.,
Director-Business Operations

After two dismal years of curtailed capital equipment investment, the spending pendulum is swinging upward. Those of you who responded to our survey last fall indicate you'll increase capital spending 32 percent over 1983. The total spending will be about $9.3 billion, compared to $7.0 billion last year.

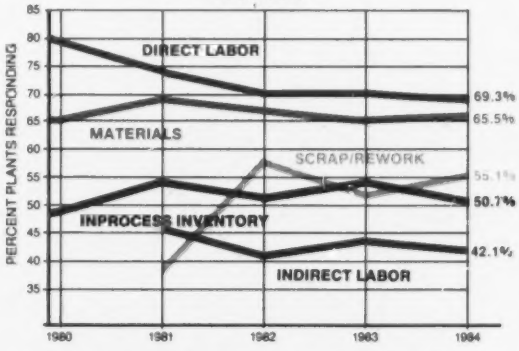
Here's how you report you will apportion your machinery and equipment investments in 1984:

Machines/Equipment	Percent of Total Investment 1984	Projection (Mil. $)	Percent Change 1984 from 5-Year Average
Metalcutting	38.6	3580*	+13.5
Assembly	13.9	1290	– 7.9
Metal forming	12.7	1180**	+10.4
Cleaning/finishing	6.9	642	– 2.8
Gaging/inspection/testing	6.9	642	+13.0
Material handling	5.4	502	–18.1
Weld/rivet/braze	5.2	483	same
Plastic molding	2.4	233	–22.5
Heat processing	2.2	205	–15.3
Other	6.0	558	–33.9

* *$2360 million to be sourced domestically*
** *$800 million to be sourced domestically*

Advanced manufacturing technologies are very much in your capital spending plans. In the following paragraphs we're looking at buying intentions for manufacturing cells and flexible manufacturing systems, robotics, laser systems, electrical discharge machines, computers and numerical control.

MAJOR COST REDUCTION TARGETS 1980-1984



Direct labor and cost of materials continue as the major targets for cost reduction as in past years. Scrap and rework grow in importance as difficult business conditions continue

Cells and Systems

Nearly 14 percent of our respondents (13.7%) reported that their plans include purchase of manufacturing cells in the next three years. While this was not surprising, the fact that 11.5 percent of you reported that flexible manufacturing systems (FMS) are in your plans was. We've observed confusion involved with investments in this direction over the past few years due to lack of a common terminology, so we defined what we had in mind.* Based on these definitions, here are the industries that report plans for near-term purchases of each type.

*A manufacturing cell is comprised of one materials handling device servicing multiple machines both of which are coordinated and placed by a computer or programmable controller. A flexible manufacturing system (FMS) is comprised of multiple materials handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.

FUTURE INSTALLATIONS OF CELLS AND SYSTEMS

SIC	Industry	Cells	Systems
3423	Hand and edge tools	X	
3494	Valves and pipe fittings	X	X
351	Engines and turbines	X	
352	Farm and garden equipment	X	
3531-2-3	Construction machinery, mining, and oil field machinery	X	X
3541	Metalcutting machine tools	X	
354	Metalworking machinery		X
356	General industrial machinery and equipment	X	X
359	Miscellaneous machinery, except electrical	X	X
3621	Electric motors and generators	X	X
371	Motor vehicle, motor vehicle parts and accessories	X	X
372	Aircraft and parts	X	X
382	Measuring and controlling instruments		X

An important observation was noted from the survey. About 30 percent of those respondents planning flexibility in their manufacturing operations will be using processes other than metalcutting. For them, "FMS" means flexible *manufacturing* system.

Robotics

More than a third (33.9%) of the total respondents will buy robots in the next three years. Companies planning to use robotics cover the spectrum of metalworking industries. The majority of installations, however, likely will be accounted for by the following industries: forging and stamping, valves and fittings, engines and turbines, farm and garden, construction/mining/oil field and material handling equipment, metalcutting machine tools (both as users and as OEMs), contract machine shops, electric motor and control, lighting equipment, automotive and parts, and aircraft and parts.

Robot applications and planned usages by those intending to purchase these devices in 1984-86 break down as follows:

Robot Use	Current	Planned
Arc welding	16.6%	9.9%
Spot welding	6.7%	5.3%
Assembly	32.0%	15.8%
Machine load/unload	41.2%	24.4%
Material handling	24.1%	13.9%
Spray painting	16.1%	10.6%
Other	3.9%	1.4%

Lasers

The survey shows 14.1 percent of respondents plan purchases of lasers in 1984-86. Of these: 16 percent will use the laser for drilling operations, 23 percent for welding, 28.9 percent for cutting, 6.2 percent for heat treat, and 51.7 percent for measurement. Laser types planned: 23.5 percent report CO_2 lasers, 15.4 percent YAG, and 19.6 percent helium-neon.

While laser purchase plans are reported pretty much across most metalworking industries, the following will account for the majority of purchases over the next few years: Valves and pipe fittings (SIC 3494), oil field machinery (SIC 3533), metalcutting machine tools (SIC 3541), independent tool and die shops (SIC 3544), machine tool accessories (SIC 3545), general industrial machinery (SIC 356), business machinery (SIC 357), contract machine shops (SIC 3599), electric motors and controls (SIC 362), communication equipment (SIC 366), electronics (SIC 367), motor vehicles, motor vehicle parts and accessories (SIC 371), aircraft and parts (SIC 372), and environmental process control instruments (SIC 382).

Electrical Discharge Machines (EDM)

Ten percent of the respondents plan purchase of EDM in the next three years. Of these, more than one-third (36.7%) will be first-time purchasers. Two-thirds of these plants plan wire EDM purchases and one-third will purchase

RAM (standard) EDM. About 10 percent of these plants will purchase both.

EDM usage continues to broaden outside the traditionally strong market made up of independent tool and die and mold maker plants (SIC 3544). In our survey, 90 percent of the plants planning EDM purchase are *not* independent tool and die and mold plants. Furthermore, the installations will generally be in large-sized plants; 76.8 percent of plants planning EDM purchase employ 100 or more, 40 percent employ 500 or more.

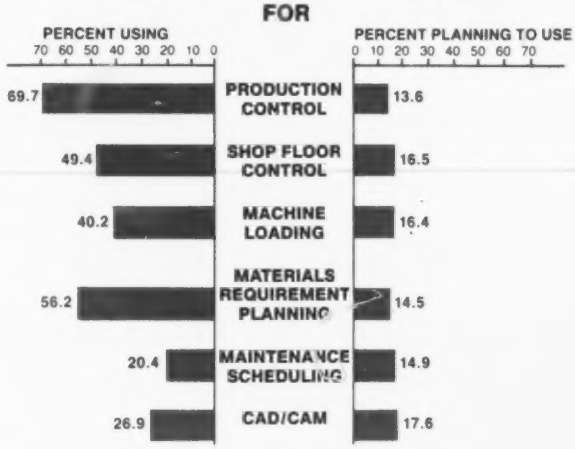
Nontraditional using industries include:

SIC	Industry	Percent of Plants Planning EDM Purchase
34	**Fabricated Metal Products** Including hand and edge tools, hardware, independent and captive stampers	22.7
35	**Machinery, except Electrical** Including engines and turbines, machine tool builders, tool, die and mold shops, machine tool accessories, business machines, contract machine shops	37.1
36	**Electrical Machinery** Including industrial controls, lighting equipment, wiring devices, communications equipment, electronic devices	16.3
37	**Transportation Equipment** Including automotive parts and accessories, aircraft engines, aircraft equipment	12.4
38	**Instruments** Including environmental and process control, surgical, medical and dental equipment	10.4

Computers

More than three-quarters of you (76.2%) reported that your plans call for first-time, or increased, use of computers in your manufacturing operations over the next three years. Many of you will use these devices to control manufacturing cells and/or flexible manufacturing systems that you will install over that period of time. But that's only part of the story about computers. The use of computerized data systems continues to expand as these management tools enable you to make better and faster decisions to improve your manufacturing costs and profits.

USE OF COMPUTERIZED DATA SYSTEMS FOR



Numerical Control

Numerically controlled equipment continues to account progressively for more of your metalcutting, metal forming, gaging and assembly operations. In the last eight years the number of plants reporting that their purchase plans included NC or CNC equipment jumped from 34.4 percent in 1977 to 46.4 percent this year—a gain of almost 35 percent! And 59.3 percent of you report that your plant operates NC or CNC equipment.

Here are the types of CNC machines the plants that plan purchase of CNC equipment intend to buy over the next three years, with year of expected purchase indicated:

PERCENT INTENDING TO PURCHASE NC OR CNC

Equipment Type	1984	1985	1986
Machining Centers-Horiz.	27.2	19.1	10.4
Machining Centers-Vert.	28.8	16.1	8.9
Turning-Horiz.	37.2	23.1	11.9
Turning-Vert.	6.7	5.8	3.9
Boring	6.4	4.6	3.9
Drilling	10.4	6.6	4.6
Grinding	10.5	8.1	6.2
Milling	13.0	9.2	5.7
Punching	9.0	5.5	3.2

Spending Patterns

For each of the eight production equipment categories shown below, the industries that are listed will account for the bulk* of the total 1984 investment in that type of equipment. Industries not listed will not invest significantly in equipment of that type.

You can compare your company's investment pattern with your industry's spending plans by determining the percentage of your capital investment budget that will go for each of these eight equipment categories.

**These industries account for 75 percent or more of the planned investment for these types of equipment, according to our 1984 Capital Spending Survey.*

Metal Forming Machinery and Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	20.7
343	Heating equipment, except electric and plumbing fixtures	14.2
344	Fabricated structural steel products	25.6
345	Screw machine products	14.4
346	Forgings and stampings	42.3
352	Farm and garden machinery	22.4
353	Construction, mining, oil field and material handling equipment	12.8
358	Refrigeration and service industry machinery	34.5
361	Electrical transmission and distribution equipment	12.2
363	Household appliances	23.5
364	Electrical lighting and wiring equipment	23.0
371	Motor vehicles, motor vehicle equipment	13.3
373	Shipbuilding and repairing	13.5

Metalcutting Machine Tools

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	32.6
345	Screw machine products	60.5
348	Ordnance and accessories, except vehicles and missiles	45.6
349	Miscellaneous fabricated products	42.1
351	Engines and turbines	64.7
353	Construction, mining, oil field and material handling equipment	44.8
354	Metalworking machinery and equipment	70.5
355	Special industry machinery	58.8
356	General industry machinery and equipment	54.5
359	Miscellaneous machinery, except electric	65.2
362	Electrical industrial apparatus	30.1
371	Motor vehicles, motor vehicle equipment	31.8
372	Aircraft and parts	56.0
381	Engineering laboratory, scientific and research instruments	51.6
382	Measuring and controlling instruments	35.2

Heat Processing Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	5.3
346	Forgings and stampings	5.0
349	Miscellaneous fabricated products	3.6
351	Engines and turbines	4.5
353	Construction, mining, oil field and material handling equipment	2.4
354	Metalworking machinery and equipment	2.7
356	General industry machinery and equipment	2.4
361	Electrical transmission and distribution equipment	4.9
363	Household appliances	3.8
365	Radio and television	5.4
367	Electronic components and accessories	4.0
372	Aircraft and parts	2.2

Weld/Rivet/Braze Equipment

SIC	Industry	Percent of Total Capital Expenditures
343	Heating equipment, except electric and plumbing fixtures	7.6
344	Fabricated structural steel products	18.1
346	Forgings and stampings	5.2
348	Ordnance and accessories, except vehicles and missiles	8.5
349	Miscellaneous fabricated products	6.4
352	Farm and garden machinery	8.3
353	Construction, mining, oil field and material handling equipment	11.2
355	Special industry machinery	5.7
356	General industry machinery and equipment	4.8
358	Refrigeration and service industry machinery	10.3
361	Electrical transmission and distribution equipment	5.5
363	Household appliances	4.7
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	4.8
371	Motor vehicles, motor vehicle equipment	7.2
373	Shipbuilding and repairing	17.6

Cleaning/Finishing Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	10.3
343	Heating equipment, except electric and plumbing fixtures	7.7
344	Fabricated structural steel products	10.6
348	Ordnance and accessories, except vehicles and missiles	11.1
349	Miscellaneous fabricated products	6.6
352	Farm and garden machinery	12.6
353	Construction, mining, oil field and material handling equipment	7.3
356	General industry machinery and equipment	6.0
358	Refrigeration and service industry machinery	12.1
361	Electrical transmission and distribution equipment	6.0
363	Household appliances	9.9
364	Electrical lighting and wiring equipment	8.9
367	Electronic components and accessories	7.2
371	Motor vehicles, motor vehicle equipment	8.9
372	Aircraft and parts	7.7
373	Shipbuilding and repairing	12.3
382	Measuring and controlling instruments	6.8

Gaging/Inspection/Testing Equipment

SIC	Industry	Percent of Total Capital Expenditures
345	Screw machine products	6.5
346	Forgings and stampings	8.4
348	Ordnance and accessories, except vehicles and missiles	6.6
351	Engines and turbines	6.2
353	Construction, mining, oil field and material handling equipment	6.3
354	Metalworking machinery and equipment	6.7
357	Office, computing and accounting machinery	12.9
359	Miscellaneous machinery, except electric	9.3
361	Electrical transmission and distribution equipment	9.4
362	Electrical industrial apparatus	12.6
365	Radio and television	17.5
366	Communication equipment	13.8
367	Electronic components and accessories	7.9
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	10.0
371	Motor vehicles, motor vehicle equipment	6.6
372	Aircraft and parts	9.3
381	Engineering laboratory, scientific and research instruments	11.3
382	Measuring and controlling instruments	10.8
384	Surgical, medical and dental instruments and supplies	7.3

Plastic Molding Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	2.7
343	Heating equipment, except electric and plumbing fixtures	2.1
348	Ordnance and accessories, except vehicles and missiles	2.1
349	Miscellaneous fabricated products	3.8
351	Engines and turbines	8.5
352	Farm and garden machinery	2.1
358	Refrigeration and service industry machinery	4.5
361	Electrical transmission and distribution equipment	5.0
362	Electrical industrial apparatus	2.8
363	Household appliances	13.8
364	Electrical lighting and wiring equipment	8.1
365	Radio and television	6.6
367	Electronic components and accessories	3.8
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	6.4
382	Measuring and controlling instruments	3.2
384	Surgical, medical and dental instruments and supplies	9.6

Assembly Machines/Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools and hardware	15.2
343	Heating equipment, except electric and plumbing fixtures	23.0
357	Office, computing and accounting machinery	36.5
358	Refrigeration and service industry machinery	11.4
361	Electrical transmission and distribution equipment	23.7
362	Electrical industrial apparatus	26.0
363	Household appliances	24.9
364	Electrical lighting and wiring equipment	23.7
365	Radio and television	37.6
366	Communications equipment	36.4
367	Electronic components and accessories	34.2
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	35.1
371	Motor vehicles, motor vehicle equipment	15.6
381	Engineering laboratory, scientific and research instruments	16.3
382	Measuring and controlling instruments	22.6
384	Surgical, medical and dental instruments and supplies	26.1

Our Golden Anniversary

PRODUCTION

APRIL 1984

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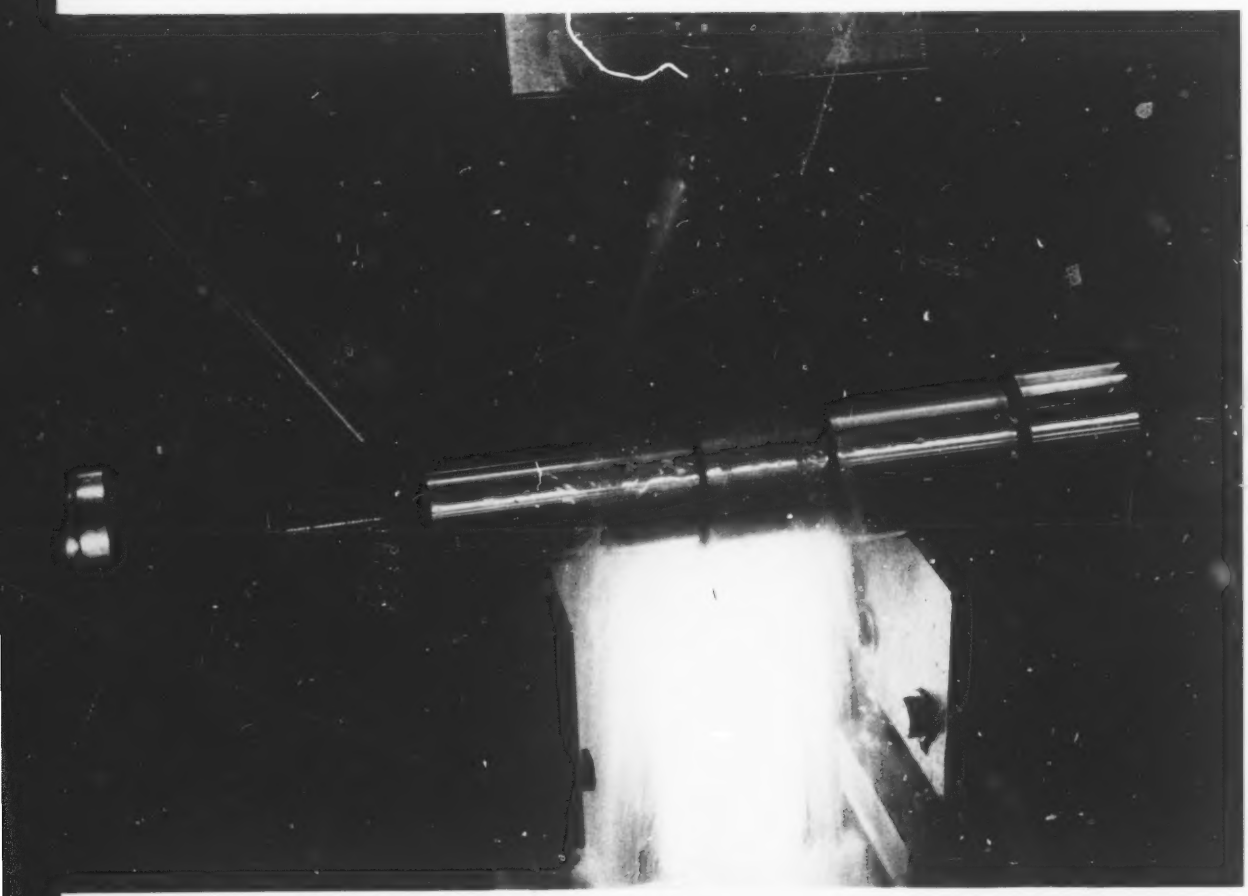

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Production Publishing Company, Inc.
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April 1984

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THE COVER:
One of the newest, Landis Tool Co.'s CNC Sizefinder automatically finish grinds multi-diameter parts automatically and precisely.

NEXT MONTH:
Spotlight on MACHINING CENTERS reveals the latest state-of-the-art along with manufacturing benefits to be gained from one of the industry's most flexible and versatile type machines.

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make more than a tiny dent in the budget deficit."

He concludes: "The bottom line to this discussion is simple. While the economy has been able to survive deficits in the past, it has never before encountered ones of today's magnitudes relative to the economy without significant side effects. There is no need to hunt for the villain in this deficit scenario—everyone deserves a share of the blame. Responsibility for today's deficits lies with the Congress, this and previous Administrations—and the American people who have continually asked for more from Washington than they were willing to ante up in the form of taxes.

"What matters at this point is that the deficit must be tackled immediately, if not sooner. Today's deficit may be boosting economic activity but tomorrow's will surely curtail it. Cutting the deficit quickly may be hard, but waiting until after the elections will not make the job any easier." □

INDUSTRY REPORT

CAD/CAM Industry Still Expanding

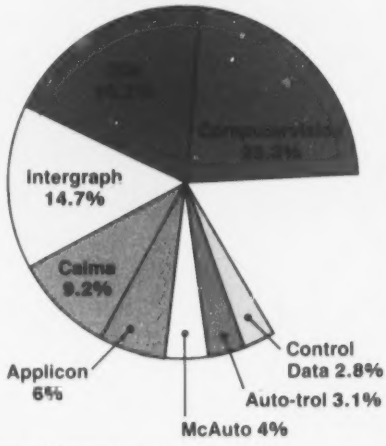
CAD/CAM industry revenues topped $1.7 billion in 1983, representing an annual growth rate of 32 percent, according to a recent survey. After sluggish growth in the first half of the year, sales picked up with a vengeance and pushed revenues far past the 28 percent growth rate of 1982. The growth rate was still below the 40 percent growth recorded in 1981, however, reports Daratech, Inc., Cambridge, MA.

New CAD/CAM vendors continue to enter the market in record numbers. By Daratech's count, the number of vendors selling CAD/CAM systems in the U.S. has increased five-fold, from about 20 at the end of 1980 to well over 100 in 1983, with no growth letup in sight. The shakeout of weaker companies that many expected in 1983 still seems a long way off.

The survey results indicate that in the ongoing battle for market share, IBM, Intergraph, McAuto and Control Data all gained ground. Intergraph, the fastest growing vendor in 1982, was also the growth leader in 1983.

IBM, whose CAD/CAM sales to end users grew a little faster than the industry in 1983, is predicted to pass Computervision to become the industry's leading supplier in 1984. Copies of the survey are available for $168 from Daratech, Inc., P.O. Box 410, Cambridge, MA 02238.

1983 CAD/CAM Market Shares



Source: Daratech, Inc., Cambridge, MA

FMS News

Cincinnati Milacron, Cincinnati, has begun manufacture of components of a large flexible manufacturing system for **FMC Corp.** The $8-million system will be installed at FMC's Aiken, SC, plant where it will be used initially to produce a family of parts for the U.S. Army's Bradley Fighting Vehicle. Future plans for the system include the manufacture of components for the Army's Multiple Launch Rocket System.

The new order is part of a long-range technology implementation program at FMC, according to a spokesman there.

For the Bradley Fighting Vehicle production, the system has been designed to manufacture a family of 17 basic parts, entailing some 23 operations. Parts are expected to be produced at a rate of 15 ship-sets per week.

Cross & Trecker Buys Bendix Automation

Cross & Trecker Corp., Bloomfield Hills, MI, has purchased the Bendix Automation Systems Group from Allied Corp. for $65 million in cash and one million warrants to buy shares of its common stock.

Cross & Trecker spokesman Richard Priebe told PRODUCTION that the sale includes all units of Bendix Automation involved in machine tool operations with the exception of the Bendix/Comau joint venture overseas operations. The domestic portion of that joint venture was included in the sale.

The Bendix Automation units

C7875-14

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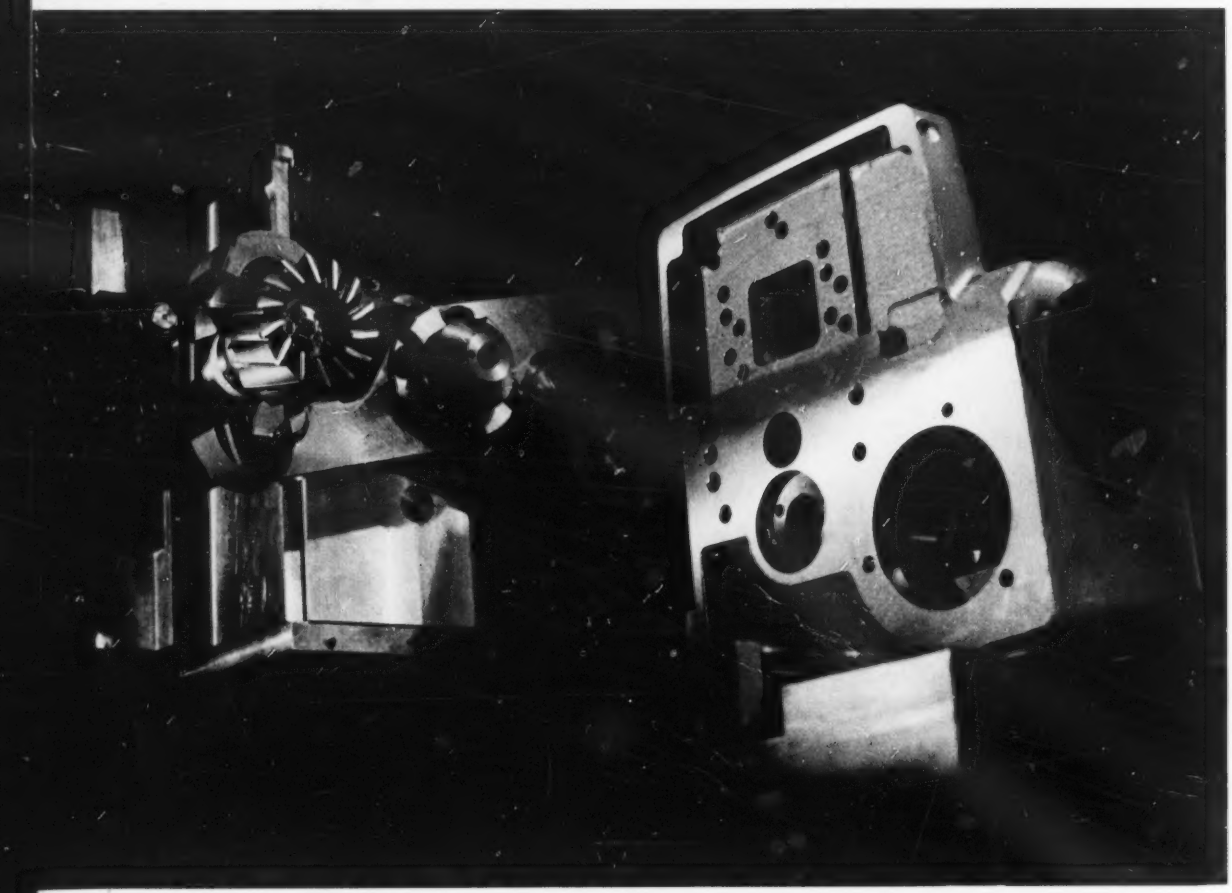

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Production Publishing Company, Inc.
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THE COVER:
Automatic tool changing symbolizes the versatility and basic advantages of machining centers. Photo courtesy of Kearney & Trecker.

NEXT MONTH:
Spotlight on METAL FORMING reveals the latest technological developments, including the various aspects of stamping, punching, shearing, press brake operations, and more. Controls play an important part.

Represent expanded editorial coverage starting this month

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conveniently surveys monthly the country's leading financial forecasting firms, has this to report in the March findings: "The consensus of our sample of 48 top economists shifted back to the promise of a more buoyant 1984—reflecting a stronger-than-expected first quarter start for the year. The full year-over-year forecast by the group now sees a growth of 5.4%—back to the projection of last December and up from the 3.3% gain in 1983. This puts the fourth-quarter-over-fourth-quarter figure at a good 4.6% gain—compared to the unusually high 6.1% fourth quarter of 1983 vs. the cyclical low quarter in 1982. In contrast, the expected activity for 1985 eased a bit to 3.3% from the 3.4% figure a month ago."

Other Eggert notes: Inflation in 1984 as it affects the Gross National Product is up, to 4.6% from 4.2%. There is some disagreement about the future of interests, but on average, the rates for short-term three-month Treasury Bills are expected to rise by more than one-half a percentage point to 9.6% by the fourth quarter of 1985.

The Negatives

Those who remember Johnny Mercer's song know that the complete title is: "Accentuate the Positive; Eliminate the Negative." The two continuing clouds are, first, the federal deficit and what, if anything, can or will be done about it; and second, unemployment rates for the year are seen at about a 7.8% level, not bad in the light of recent history and the growing labor force, but no comfort to those who can't find work. *Robert F. Huber* □

INDUSTRY REPORT

GM Buys 13 Giant Milling Machines from Toshiba

Toshiba Machine Co., Ltd., Tokyo, Japan, has announced that it has received an order from General Motors for 13 giant Model BFD-200 horizontal die milling machines. The automaker will use the machines to "beef up" the auto body stamping die making operations of the Fisher Body Div. Toshiba reports that the machines will be installed at GM's Michigan facilities in Grand Blanc, Grand Rapids, and Kalamazoo, and at Mansfield, OH. BFD-200 machines will also be installed at GM's facility in Marian, IN.

The BFD-200 units are CNC double-column floor-type machines with six to seven axes (five simultaneous) which can profile large complicated workpieces. Deliveries of the machines will begin in August.

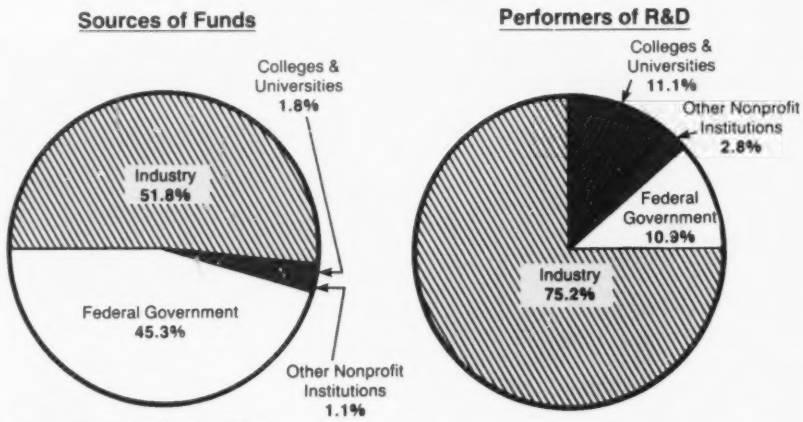
R & D Expenditures Rise 9 Percent in 1984

Research and Development expenditures are expected to reach $94.2 billion in the U.S. during calendar year 1984 according to the annual forecast of Battelle Memorial Institute's Columbus Div. This represents an increase of $7.7 billion (8.9 percent) over the $86.5 billion the National Science Foundation estimates was actually spent for R&D in 1983.

While much of the increase will be absorbed by continued inflation (estimated at 5 percent), Battelle forecasts a real increase in expenditures of 3.7 percent. This is slightly higher than the ten-year average of 3.3 percent.

The report notes that during the past decade industrial support of R&D has increased at an average compounded rate of 5.2 percent per year, while federal support has increased at 2.9 percent on average.

R&D Expenditures In the U.S., Calendar Year 1984



Source: Battelle's Columbus Division